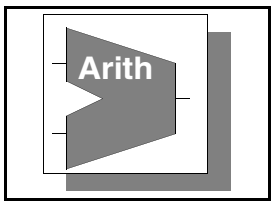
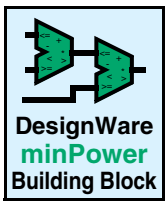




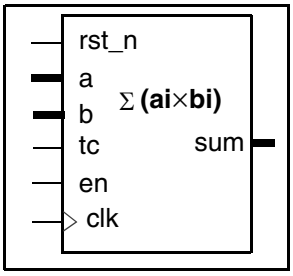
DW_prod_sum_pipe

Stallable Pipelined Generalized Sum of Products

Version, STAR, and myDesignWare Subscriptions: IP Directory

Features and Benefits

Revision History



- Re-uses the DW02_prod_sum component and adds pipeline structures
- Parameterized word length
- Unsigned and signed (two's complement) data operation
- Parameterized number of pipeline stages
- Parameterized stall mode (stallable or non-stallable)
- Parameterized reset mode (no reset, asynchronous or synchronous reset)
- Automatic pipeline retiming
- Provides minPower benefits (for details, see Table 1-3 on page 3)

Description

DW_prod_sum_pipe is a universal stallable pipelined generalized sum of products generator.

Table 1-1 Pin Description

Pin Name	Width	Direction	Function
clk	1 bit	Input	Input clock
rst_n	1 bit	Input	Reset, active-low (not used if parameter *rst_mode* = 0)
en	1 bit	Input	Register enable, active high (used only if parameter *stall_mode* = 1) ■ 0: Stall ■ 1: Enable register
tc	1 bit	Input	Two's complement control ■ 0: Unsigned ■ 1: Signed
a	*a_width* × *num_inputs* bits	Input	Concatenated input data vector
b	*b_width* × *num_inputs* bits	Input	Concatenated input data vector
sum	*sum_width* bits	Output	Pipelined data summation

Table 1-2 Parameter Description

Parameter	Values	Description
a_width	≥ 1 Default: None	Word length of `a`
b_width	≥ 1 Default: None	Word length of `b`
num_inputs	≥1 Default: 2	Number of inputs
num_stages	≥ 2 Default: 2	Number of pipeline stages
stall_mode	0 or 1 Default: 1	Stall mode ■ 0: Non-stallable ■ 1: Stallable
rst_mode	0 to 2 Default: 1	Reset mode ■ 0: No reset ■ 1: Asynchronous reset ■ 2: Synchronous reset
sum_width	≥ 48 Default: None	Word length of sum
op_iso_mode	0 to 4 Default: 0	Operand isolation mode (controls datapath gating for minPower flow) Allows you to set the style of minPower datapath gating for this module ■ 0: Use the DW_lp_op_iso_mode[a] synthesis setting ■ 1: 'none' ■ 2: 'and' ■ 3: 'or' ■ 4: Preferred gating style: ‘and’ For details about enabling minPower datapath gating for this component, see “Enabling minPower” on page 7.

a. The DW_lp_op_iso_mode synthesis variable is available only in Design Compiler.
DW_lp_op_iso_mode sets a global style of datapath gating. To use the global style, set *op_iso_mode* to '0', Note that If the *op_iso_mode* parameter is set to '0' and DW_lp_op_iso_mode is either not set or set to 0', then no datapath gating is inserted for this component.

Table 1-3 Synthesis Implementations

Implementation Name	Implementation	License Feature Required
str	Pipelined str synthesis model	DesignWare
lpwr[a]	Low Power synthesis model	■ DesignWare (P-2019.03 and later) ■ DesignWare-LP (before P-2019.03)

a. Requires that you enable minPower; for details, see "Enabling minPower" on page 7.
When minPower is enabled, the lpwr implementation is always chosen during synthesis.

Table 1-4 Simulation Models

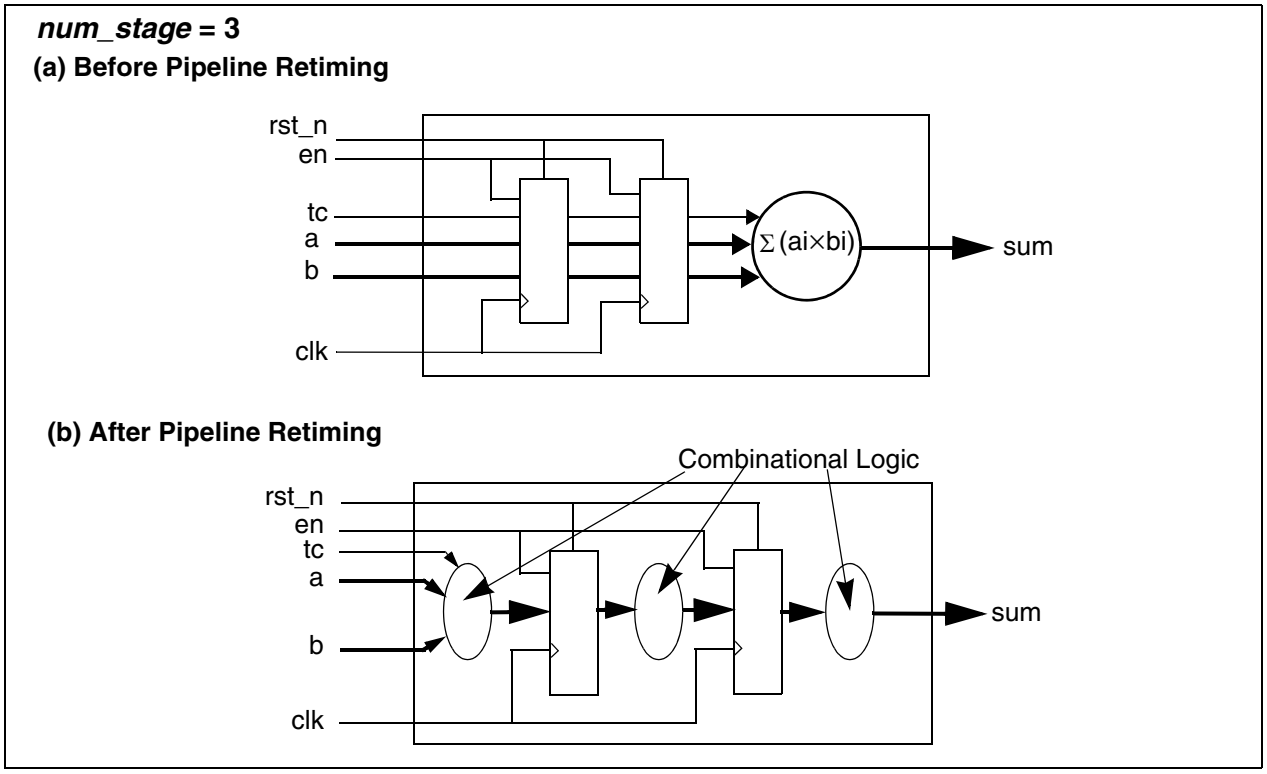
Model	Function
DW02.DW_PROD_SUM_PIPE_CFG_SIM	Design unit name for VHDL simulation
dw/dw02/src/DW_prod_sum_pipe_sim.vhd	VHDL simulation model source code
dw/sim_ver/DW_prod_sum_pipe.v	Verilog simulation model source code

DW_prod_sum_pipe computes the generalized sum of products of input vectors `a` and `b` with a latency of `num_stages` – 1 clock cycles. The vectors `a` and `b` are formed by concatenation of corresponding inputs to be multiplied and summed. The input pin `tc` determines whether the input and output data is interpreted as unsigned (`tc` = 0) or signed (`tc` = 1) numbers.

Automatic pipeline retiming ensures optimal placement of pipeline registers within the generalized sum of products generator to achieve maximum throughput. The pipeline can be stalled by setting the load enable signal `en` to a low (when *stall_mode* = 1). The pipeline registers can either have no reset (*rst_mode* = 0) or an asynchronous (*rst_mode* = 1) or synchronous reset (*rst_mode* = 2) connected to the reset signal `rst_n`.

Figure 1-1 shows the block diagram of a 3-stage DW_prod_sum_pipe component.

Figure 1-1 Pipeline Retiming



Suppressing Warning Messages During Verilog Simulation

The Verilog simulation model includes macros that allow you to suppress warning messages during simulation.

To suppress all warning messages for all DWBB components, define the DW_SUPPRESS_WARN macro in either of the following ways:

- Specify the Verilog preprocessing macro in Verilog code:

  ```
  `define DW_SUPPRESS_WARN
  ```

- Or, include a command line option to the simulator, such as:

  `+define+DW_SUPPRESS_WARN` (which is used for the Synopsys VCS simulator)

The warning messages for this model include the following:

- If values other than 1 or 0 are present on a clock port, the following message is displayed:

  ```
  WARNING: <instance_path>.<clock_name>_monitor:
      at time = <timestamp>, Detected unknown value, x, on <clock_name> input.
  ```

  To suppress only this warning message for all DWBB components, use the following macro:

  - Define the DW_DISABLE_CLK_MONITOR macro. You can define this macro in the following ways:
    - Specify the Verilog preprocessing macro in Verilog code:

      ```
      `define DW_DISABLE_CLK_MONITOR
      ```

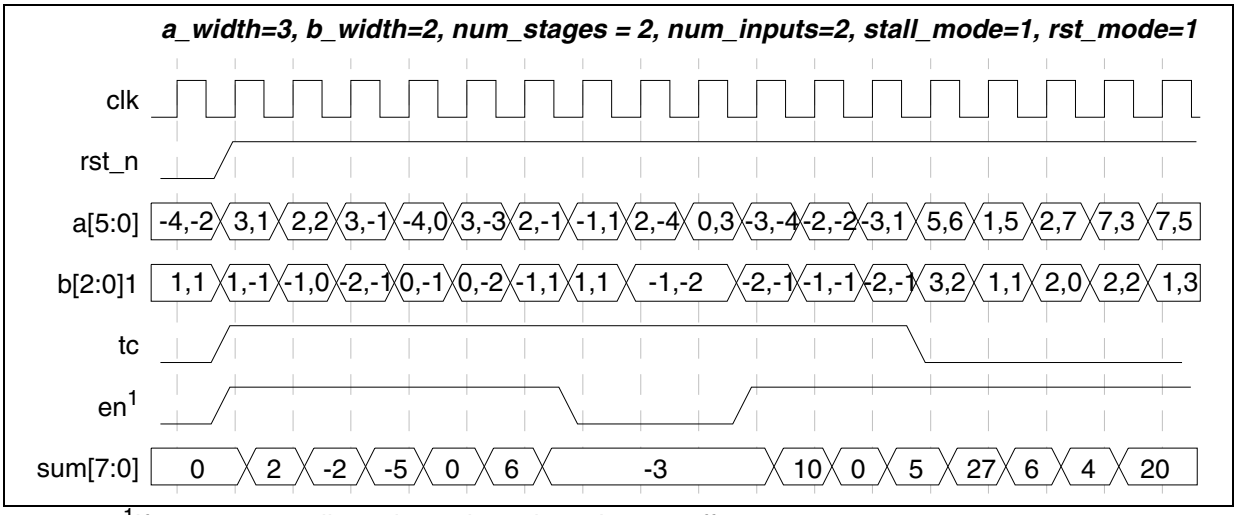
    - Or, include a command line option to the simulator, such as:

      `+define+DW_DISABLE_CLK_MONITOR` (which is used for the Synopsys VCS simulator)

  This message is also suppressed using the DW_SUPPRESS_WARN macro explained earlier.

Timing Waveform

Figure 1-2 Waveform 1



[1]If parameter stall_mode=0, then pin en has no effect.

Figure 1-3 Waveform 2

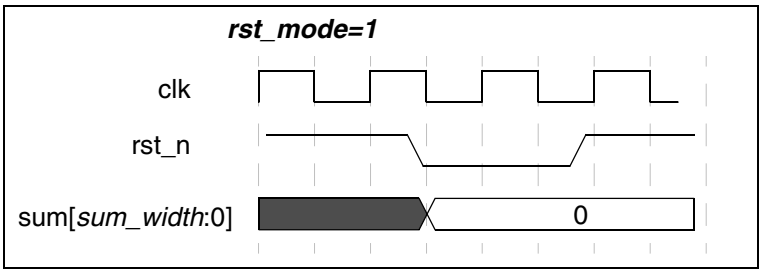
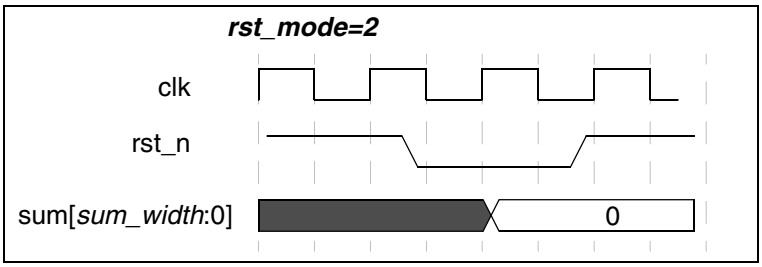


Figure 1-4 Waveform 3



Enabling minPower

You can instantiate this component without enabling minPower, but to achieve datapath gating power savings, you must enable minPower optimization, as follows:

- Design Compiler
  - Version P-2019.03 and later:

    ```
    set power_enable_minpower true
    ```

  - Before version P-2019.03 (requires the DesignWare-LP license feature):

    ```
    set synthetic_library {dw_foundation.sldb dw_minpower.sldb}
    set link_library {* $target_library $synthetic_library}
    ```

- Fusion Compiler

  Optimization for minPower is enabled as part of the total_power metric setting. To enable the total_power metric, use the following:

  ```
  set_qor_strategy -stage synthesis -metric total_power
  ```

Related Topics

- Math – Arithmetic Overview
- DesignWare Building Block IP User Guide

HDL Usage Through Component Instantiation - VHDL

```
library IEEE,DWARE;
use IEEE.std_logic_1164.all;
use DWARE.DWpackages.all;
use DWARE.DW_Foundation_comp_arith.all;

entity DW_prod_sum_pipe_inst is
  generic (inst_a_width    : POSITIVE := 2;  inst_b_width     : POSITIVE := 2;
           inst_num_inputs : POSITIVE := 2;  inst_sum_width   : POSITIVE := 4;
           inst_num_stages : POSITIVE := 2;  inst_stall_mode  : NATURAL := 1;
           inst_rst_mode   : NATURAL := 1;   inst_op_iso_mode : NATURAL := 0 );
  port (inst_clk   : in std_logic;
        inst_rst_n : in std_logic;
        inst_en    : in std_logic;
        inst_tc    : in std_logic;
        inst_a     : in std_logic_vector(inst_a_width*inst_num_inputs-1 downto 0);
        inst_b     : in std_logic_vector(inst_b_width*inst_num_inputs-1 downto 0);
        sum_inst   : out std_logic_vector(inst_sum_width-1 downto 0) );
end DW_prod_sum_pipe_inst;

architecture inst of DW_prod_sum_pipe_inst is
begin
  -- Instance of DW_prod_sum_pipe
  U1 : DW_prod_sum_pipe
    generic map (a_width => inst_a_width,   b_width => inst_b_width,
                 num_inputs => inst_num_inputs,  sum_width => inst_sum_width,
                 num_stages => inst_num_stages,   stall_mode => inst_stall_mode,
                 rst_mode => inst_rst_mode,  op_iso_mode => inst_op_iso_mode  )
    port map (clk => inst_clk,   rst_n => inst_rst_n,
              en => inst_en,   tc => inst_tc,   a => inst_a,   b => inst_b,
              sum => sum_inst  );
end inst;

-- Configuration for use with VSS simulator
-- pragma translate_off
configuration DW_prod_sum_pipe_inst_cfg_inst of DW_prod_sum_pipe_inst is
  for inst
  end for; -- inst
end DW_prod_sum_pipe_inst_cfg_inst;
-- pragma translate_on
```

HDL Usage Through Component Instantiation - Verilog

```
module DW_prod_sum_pipe_inst( inst_clk, inst_rst_n, inst_en, inst_tc,
                              inst_a, inst_b, sum_inst );

  parameter inst_a_width = 2;
  parameter inst_b_width = 2;
  parameter inst_num_inputs = 2;
  parameter inst_sum_width = 4;
  parameter inst_num_stages = 2;
  parameter inst_stall_mode = 1;
  parameter inst_rst_mode = 1;
  parameter inst_op_iso_mode = 0;

  input inst_clk;
  input inst_rst_n;
  input inst_en;
  input inst_tc;
  input [inst_a_width*inst_num_inputs-1 : 0] inst_a;
  input [inst_b_width*inst_num_inputs-1 : 0] inst_b;
  output [inst_sum_width-1 : 0] sum_inst;

  // Instance of DW_prod_sum_pipe
  DW_prod_sum_pipe #(inst_a_width, inst_b_width, inst_num_inputs,
                     inst_sum_width, inst_num_stages, inst_stall_mode,
                     inst_rst_mode, inst_op_iso_mode)
    U1 (.clk(inst_clk),   .rst_n(inst_rst_n),
        .en(inst_en),     .tc(inst_tc),
        .a(inst_a),       .b(inst_b),
        .sum(sum_inst) );
endmodule
```

Revision History

For notes about this release, see the *DesignWare Building Block IP Release Notes*.

For lists of both known and fixed issues for this component, refer to the STAR report.

For a version of this datasheet with visible change bars, click here.

Date	Release	Updates
July 2020	DWBB_201912.5	■ Adjusted content and title of "Suppressing Warning Messages During Verilog Simulation" on page 5 and added the DW_SUPPRESS_WARN macro
October 2019	DWBB_201903.5	■ Added the "Disabling Clock Monitor Messages" section
March 2019	DWBB_201903.0	■ Clarified the op_iso_mode parameter in Table 1-2 on page 2 ■ Clarified license requirements in Table 1-3 on page 3 ■ Added "Enabling minPower" on page 7 ■ Added this Revision History table and the document links on this page

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